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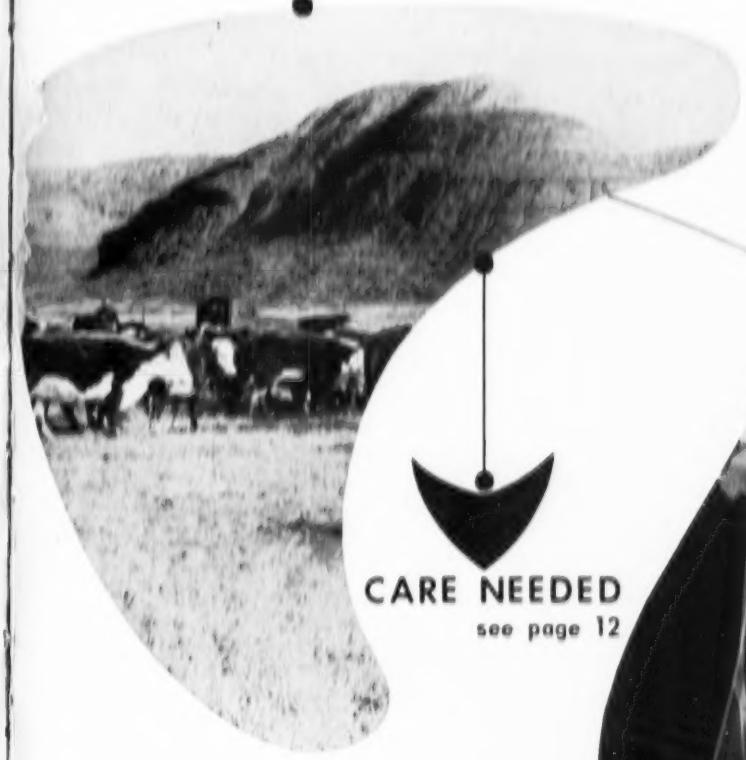

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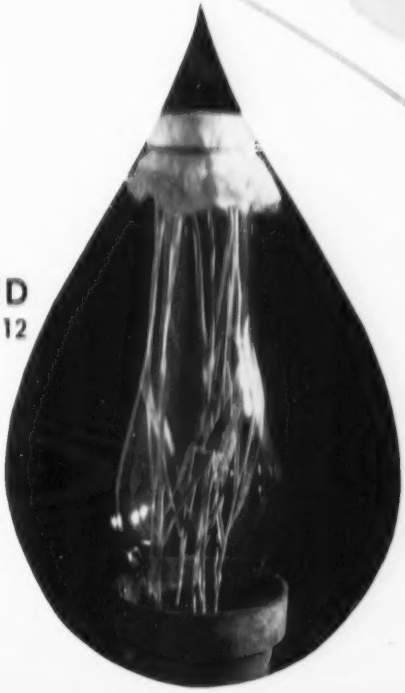

BREEDERS AIDED
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UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURAL
Research

Vol. 4—May 1956—No. 11

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Slow down?

Agriculture is battling surpluses. Does it make sense to continue to spend money on agricultural research?

It does. And here are some of the reasons:

In the first place, research stands behind the gains we've made up to now. Many's the time it has saved farmers from disaster. Race 15B of stem rust struck our durum-wheat belt in 1950 and farmers faced total loss. In just 6 years since then, plant breeders have created 4 new resistant varieties of durum (a type of wheat of which there's no surplus).

As we pointed out a few months ago, cost cutting is one of the main efforts in research today. That's one way of getting at the cost-price squeeze. The broiler industry shows what cost reduction can do. The amount of feed required to produce a broiler has been cut 25 percent since 1940, and lower-cost handling and packaging have cut prices. As a result poultry meat is no higher than it was in 1930.

The fact that research improves quality and broadens markets is illustrated by our new extra-long-staple cotton, Pima S-1. It's competing well with imported cottons.

Research creates new industries. Soybeans are an outstanding example. Research not only developed the varieties that now occupy 18 million acres but also established the soybean in food markets and in hundreds of industrial uses.

And we all know research strengthens the whole Nation. We've produced enough food for every emergency. Our diets rank high and we are free from many diseases associated with poor nutrition. Gains in agricultural technology have given us manpower and materials to become the Nation we are.

Can we assume that farmers are ahead of the times, that we can slow down their progress? We dare not. Actually, as the Korean conflict demonstrated, the margin is relatively thin.

No, nature doesn't stand still: look at insects' resistance to chemicals. Industry doesn't stand still: take what synthetic fibers did to the cotton market. Our country doesn't stand still: check the latest census estimates.

Research can't stand still, either. Today's research will have a great deal to do with our agricultural prosperity of 5 to 10 years from now. We have a responsibility to the future.

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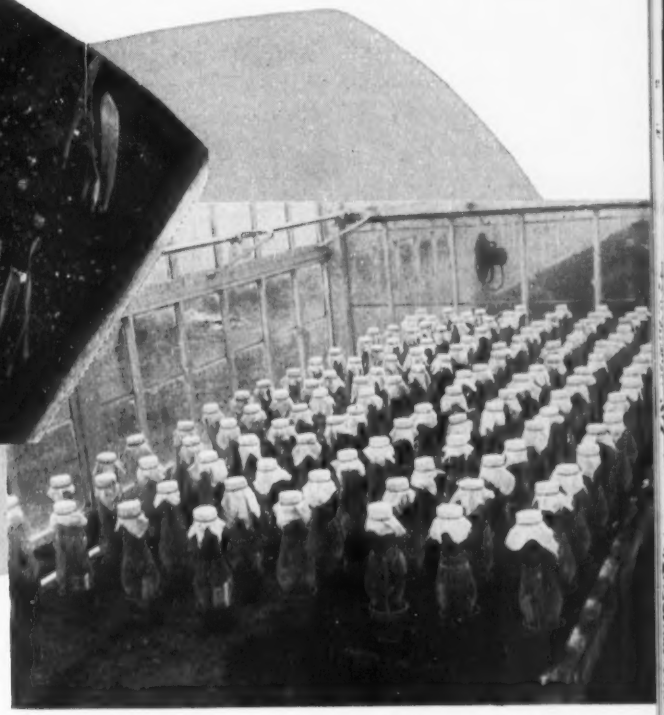
AGRICULTURAL RESEARCH SERVIC
United States Department of Agricultur

IDENTIFICATION of a race of crown rust is made by checking the effect of the rust on these 10 differential varieties of oats.

THEIR CROP IS RUST

Workers at this laboratory identify crown-rust races to aid oat breeders in developing resistant varieties



PROPAGATION of a rust to get test supply is done in old-fashioned lamp chimneys, which create ideal climate for spore growth.

LONG experience has shown that breeding new varieties of oats is the most effective way to control ravages of the fungus disease crown rust—arch enemy of oat growers.

Of more than 80 known races of crown rust, at least half are found in the United States. Many seriously menace the oat crop each year. Actually a leaf rust, the fungus gets its name from the crown-like form of one of its spore stages.

Speeding up and increasing the effectiveness of our breeding for resistance is a USDA-State operated crown-rust identification laboratory at Iowa State College, in Ames.

Crown-rust samples from every oat-growing section of the country are sent to this unimposing laboratory for identification as to race. Here, too, rust samples are often propagated to furnish adequate supplies of various races to plant breeders who need to test the resistance of oat varieties they are developing for commercial use.

Rust identification and propagation work at the laboratory is conducted by ARS plant pathologist M. D. Simons. Simons uses 10 specific varieties of oats as a means of identifying the rust samples he receives. These "differential" varieties are Anthony, Victoria, Appler, Bond, Landhafer, Santa Fe, Ukraine, Triapernia, Bondvic, and Saia. A small clump of plants of each variety occupies a specific place in an 8- by 10-inch greenhouse flat. Also included in each flat may be a new resistant variety undergoing test.

In making the identification test, one or more flats of oat plants are sprayed with a wetting agent and then dusted with the spores of a single sample of rust. After this treatment, the plants are placed in a moist chamber overnight so that infection will take place. Conditions in the chamber simulate dewy summer nights in open fields, the time when crown rust development is usually greatest.

Identity of a particular race of rust can be established once the fungus has had time to produce a new crop of spores on the oat plants. Reaction of each one of the 10 differential varieties of oats is always the same to a

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single race of rust. For example, take race 202—probably the most prevalent and damaging of all known crown rusts. A flat of the 10 differential oat plants, after inoculation, shows the Anthony, Appler, and Bond varieties susceptible, and the remaining 7 varieties resistant. By comparing these results with a chart at hand, the researcher knows that the crown rust he is testing is race 202.

For race 203, he will find 4 differential varieties susceptible, 6 resistant. Each known race of crown rust from 201 through 288 affects 1 or more of the 10 varieties and is resisted by the other test plants.

When a sample of crown rust does not react on the 10 test plants according to the charted pattern, the researchers know they are dealing with a new race. Repeated trials that show the same average of resistance and susceptibility serve to place the rust as a definite newcomer. In this case, the "unknown" is given a number designation and the pattern of its effect on the 10 test varieties of oats is duly charted. Thus, if the race shows up again, it can readily be identified.

Propagation of the rust to maintain adequate supplies to test newly developed oat varieties is a painstaking phase of the work at Ames.

Since rust samples sent in for identification are small, each race needed in plant-breeding work must be propagated to increase the supply. For this purpose, oat plants are grown in small flower pots. Each pot is tagged with the source or identification of the rust with which the plants have been treated. Old-fashioned kerosene-lamp chimneys are placed over the plants in each pot, and a layer of cheesecloth is placed over the top opening in the chimney. This method provides ideal climatic conditions within the chimneys for the propagation of rust spores. Once a supply is produced, rust spores are gathered from the plants and stored according to kind until needed for identification or to test the resistance of new oat varieties under development.

Preliminary tests for resistance to crown rust are sometimes made during identification tests. If a single new variety of oats in a flat is not attacked, researchers are certain that it is resistant to at least one race of rust. But the new variety must eventually be exposed to many races before its total pattern of resistance can be determined prior to field testing.

Thus, numerous races of rust must be propagated in the laboratory so that oat breeders can check on the resistance of each new variety to each one of the crown-rust races.

Among the 80-odd known races of crown rust, race 202 shows up in an average of 1 out of every 3 samples tested. Race 203 is another frequent caller at the identification laboratory. But some races are so rare as to be identified by the workers only once during several years of testing.☆

RESEARCHER AND FARMER AGAINST BLIND SEED

■ FARM PRACTICES devised through research have largely curbed a disease of our perennial ryegrass seed crop. It's blind-seed disease, which appeared in the United States 13 years ago and threatened this crop.

Oregon's Willamette Valley, where the disease struck, produces nearly all this country's ryegrass seeds. The disease has been rampant and destructive in New Zealand, Scotland, and other European countries.

The ryegrass seed producers were gloomy in 1943 when this disease disqualified a third of their seeds for the "blue tag" rating under seed-certification regulations. Those seeds failed the 90-percent minimum germination test. In 1944 nine-tenths of the acreage was infected, but new control practices brought the situation well into hand by 1946.

A false sense of security and the postwar market boom for seeds led many growers to discard caution in favor of maximum seed crops. So by 1948, blind-seed disease was on the march again—showed up in 80 percent of the fields and severely damaged over a third of the crop. Since then, controls have been standard procedure in the valley. And today, 13 years after the disease showed up, growers face the future optimistically but with due caution, for they have raised six crops nearly free of the disease.

Outstanding success against this disease doubtless was due to the prompt development of control measures by ARS pathologist J. R. Hardison and cooperating scientists at the Oregon experiment station. State research and extension specialists, county agents, and local leaders rallied farmers to valley-wide participation. But the farmers themselves ultimately won the contest by their thorough execution of control measures worked out by scientists.

Now a word about the disease organism. It's a fungus, *Gleotina temulenta*, that invades the seeds. In the spring, the tiny spore cups of the fungus emerge from diseased seeds and shower spores on the grass heads at flowering time. Early infection completely destroys the embryo and

no seed develops. The "blind" or non-germinating seeds are the result of infection a little later. Still-later infection may result in production of diseased seeds and yet not destroy their vitality. Such seeds continue the source of infection when they're planted or shattered on seed fields.

As the name implies, "blind seeds" are nearly indistinguishable from healthy seeds. Only an expert can distinguish the slight differences in color. It's necessary to examine seeds under a microscope and detect spores to be sure of infection.

The researchers correctly diagnosed the disease's weakness as the overwintering stage and worked out plans to destroy infected seeds. Here's the research-developed plan with which farmers met the problem:

1. Used only disease-free seeds or 2-year-old seeds and planted them at least half an inch deep.

2. Plowed in the fall or before May 1 all badly infested fields and also plowed those fields that had been in ryegrass for 3 years or more.

3. Abandoned the practice of keeping such fields for grazing.

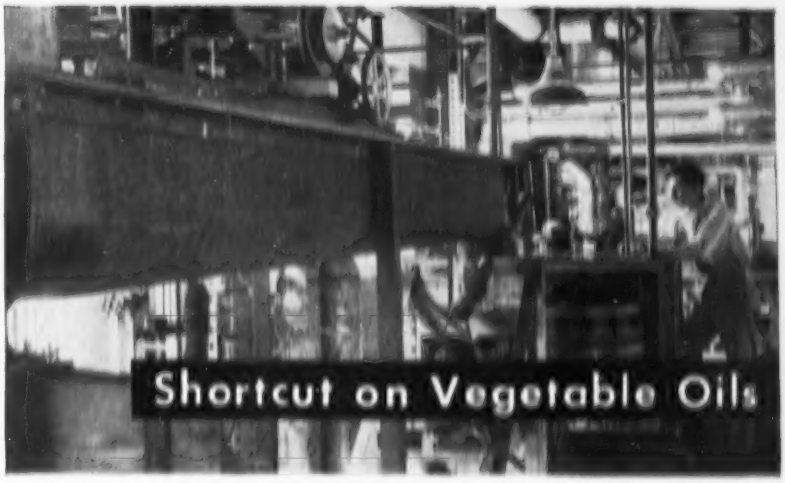
4. Burned over their lightly infested fields after August 15.

5. Adjusted combines to put light seeds in the sack rather than letting them scatter onto the ground.

6. Burned diseased screenings, rather than seed or feed them.

Extension pathologists now check seed samples from each field for prevalence of diseased seeds. Where the disease shows up, the county agent works with the grower to bring the problem under control before the beginning of the next season.

Owing to the nature of the disease, Hardison could plan a control that's popular with growers. It takes no new practice or expense—merely thoroughness and good timing in the common practices. By doing a good job, farmers have now grown six crops almost free of blind seed.☆



Shortcut on Vegetable Oils

■ A NEW SOLVENT-EXTRACTION PROCESS for extracting vegetable oil has been developed at USDA's Southern Utilization Research Branch.

Advantages of the process—called filtration-extraction—are many. It saves time and money, increases oil yield, gives high-quality oil and meal products, and is especially suitable for small and medium mills.

Present-day practice of solvent-extracting oilseeds requires many steps prior to extraction—flaking, moisture adjustment, cooking, drying, cooling, prepressing, and reforming. These steps are expensive and require special machinery and extra labor and power—especially when applied to high-fat-content oilseeds such as peanuts, sesame, and castor.

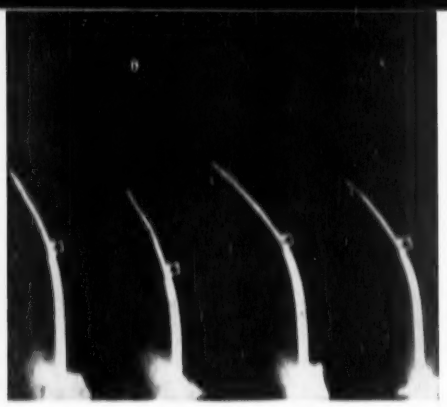
Filtration-extraction eliminates the need for prepressing high-oil-content seeds and thus reduces initial installation and power costs. It also requires a low ratio of the solvent (hexane) to oilseed meats, as well as smaller solvent equipment than with conventional processes.

In filtration-extraction, the oilseeds are rolled, cooked, and crisped in the conventional equipment—with only minor additions and slight modifications—that's used in hydraulic and screw-press mills. Specific conditions to suit each oilseed are selected for these operations. This yields a granular material in which the objectionable "fines"—material that is too finely crushed—are consolidated into larger agglomerates.

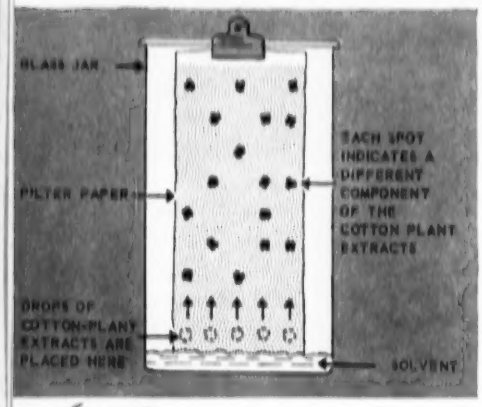
The granular material is next soaked with an oil-solvent mixture to dissolve the oil, then put on a vacuum filter. There the strong oil-solvent mixture is separated from the meal and refiltered through the meal bed to reduce its "fines" content. The resulting meal on the filter is washed and drained several times before removal. It contains only 25 to 30 percent solvent and has an oil content of 1 percent or less. Solvent is removed from the oil and meal in conventional equipment.

An advantage of the process is that with slight modification, materials of high, medium, and low oil content and of widely varying physical characteristics can be processed. Thus, where several different oilseeds are available, economical year-round operations are possible.

The new method, developed through the pilot-plant stage at the ARS utilization laboratory, has been used by industry in the design and construction of two plants. In the first commercial installation, filtration-extraction replaced hydraulic pressing, with substantial savings in operating costs. This plant processes both cottonseed and soybeans.☆



AVENA TEST results are shown in this shadowgraph (right). Attached to each oat leaf is a tiny square of agar impregnated with plant extract from cotton bolls. These oat shoots have bent away from the agar squares because the extract was strong in growth-stimulating substances. A growth-inhibiting material would have caused plants to remain straight or bend toward squares. (About half the natural sheath of the young oat plants is removed because it contains oat-plant growth factors that would interfere with cotton-boll factors under test.)


GLASS JAR
FILTER PAPER
DROPS OF COTTON-PLANT EXTRACTS ARE PLACED HERE
EACH SPOT INDICATES A DIFFERENT COMPONENT OF THE COTTON PLANT EXTRACTS
SOLVENT

CHROMATOGRAPHY (left) is used to separate the growth-promoting and growth-retarding materials found in extract from cotton bolls. As solvent is absorbed by paper and moves upward, extracts are carried along and the components deposited at different levels in spots or bands. Many such spots show stains; others must be located with a photoelectric densitometer. Paper is dried, cut crosswise at each spot or band. Then material from each section is recovered with ether and used in second *Avena* test to determine its properties.

What Causes Boll Drop ?

STUDY OF GROWTH REGULATORS FOUND IN COTTON BOLLS MAY HELP FIND A WAY TO LENGTHEN NORMAL EARLY SET

REASONS for regular occurrence of cotton boll drop are being sought by USDA and State scientists as a short route toward possible cure.

ARS plant physiologist H. R. Carns and coworkers are conducting tests at Mississippi's Delta Branch Experiment Station, Stoneville. These indicate that mixed with natural growth stimulating materials in cotton bolls is a growth inhibitor. Bolls that are *not* likely to drop may have a preponderance of the stimulant—and those that *are* likely to drop, a preponderance of the inhibiting substance.

In either field or greenhouse, abscission of cotton bolls occurs about 10 days after the date of flowering. Early in the season, boll set keeps pace fairly well with flowering. But a marked increase in boll drop follows. This continues until flowering tapers off, when boll set again picks up and extends into the fall.

Research, seeking causes of boll drop, is attempting to lengthen the normal early period of boll set when growth to maturity is most likely to occur. Unlike apples, cotton bolls have not been found to respond to regulator compounds (organic) that increase fruit set. Researchers at Stoneville find that drop varies considerably by varieties, seasons, and growing conditions. Some of these conditions are partly controllable.

Obtaining the complex plant-growth-regulator material from the bolls is relatively simple. Groups of five bolls are removed from plants at various times and under varying conditions so that changes in the potency of the material can be determined. Green bolls are immediately frozen with dry ice and stored at −24° C. Samples of the material are extracted in peroxide-free ether by mashing the bolls with mortar and pestle at a temperature below 0° C. The ether extract is concentrated by reducing the volume under vacuum.

Extracts are then checked for growth-promoting or retarding activity by the standard-curvature and straight-growth test—the *Avena*, or oat, test (see shadowgraph).

When the growth regulating capacity of boll extracts was measured by this test, the researchers found growth-retarding properties. Further, this growth-retarding effect increased with the age of the boll up to a maximum roughly coinciding with the time the young boll was most likely to drop. The activity of the growth retardant was also found to vary between varieties showing different boll-retaining capacities.

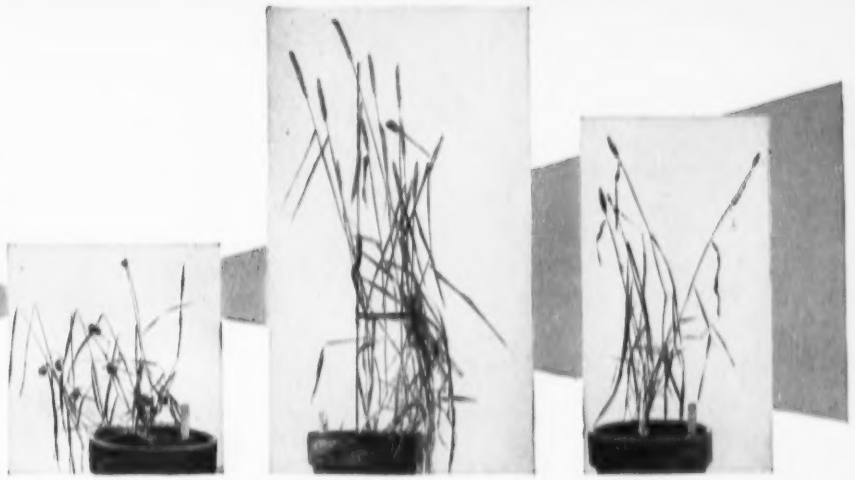
Since only growth-retarding properties were found for the complete extract, separation of its components was undertaken to study the properties of each. This was done by paper chromatography (see diagram; also AGR. RES., April 1956, p. 8), using a solvent found to work especially well with cotton plant tissue.

The components were then used individually in second *Avena* tests. In this way, the extract was shown to contain a mixture of both growth-promoting and growth-retarding materials. One retarding and three promoting substances have been found.

Carns and his associates are now attempting to isolate and identify these materials and learn more about the role they play in boll-drop.☆

Rare abnormal wheat plants, short on chromosomes, are

BARING WHEAT'S GENETIC SECRETS



RARE genetic defectives of wheat plants shortchanged on chromosome number give researchers a new insight into what the respective chromosomes do for normal wheat.

With this knowledge, our scientists are already moving more directly toward the objective of making new genetic combinations needed in wheat.

Plant geneticist E. R. Sears, working cooperatively for USDA and the Missouri experiment station, has made these discoveries with abnormal plants of Chinese Spring wheat. They're plants that in their formative stage *lost one or more* of their normal complement of chromosomes—those tiny rod-like carriers of plant character in the plasm of each cell. Such plants are called *aneuploids*.

In about 15 years, Sears has found not just *1*, but all *21* of the possible different kinds of aneuploids lacking 1 chromosome each. The 21 aneuploids are different because a different chromosome is missing in each case.

Common wheat normally has 21 *pairs* of chromosomes—one set of 21 from the male parent and their counterparts from the female parent. The 2 members of each pair are essentially alike, however, so an understanding of the 21 fundamentally different ones completes the picture. This picture becomes clearest when both members of a pair are absent, and Sears has actually obtained all 21 of the possible types (nullisomics) with only 20 pairs of chromosomes.

Sear's evaluation was indirect, yet valid, for he observed what major effect the absence of any specific chromosome has on the plant.

Here's an example of what the study showed. Absence of chromosome I (one) reduced the plant height about 30 percent, darkened the glumes or husks somewhat, and reduced fertility of the plant about 75 percent. That's a somewhat lesser effect that most of the other 20 chromosomes had on fertility and vigor.

Or consider chromosome X (ten). Its absence increases length of awns (beards), because this chromosome carries a gene that inhibits awns. Moreover, some of the usual 3 stamens—sometimes all 3 of them—are changed to pistils, and those that are retained as stamens often are infertile. Chromosome X carries 2 complementary dominant genes for resistance to Race 56 of stem rust, as well as 1 of the 2 complementary genes for a seedling's resistance to leaf rust, and a gene for the mature wheat plant's resistance to leaf rust.

Our scientists are doubly gratified at finding these plant deviates. In

Relationships of the 42 Chromosomes in a Wheat Plant

(CHROMOSOMES WERE NUMBERED BEFORE GROUPINGS WERE DISCOVERED)

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Set A 7 pairs	I I	II II	III III	IV IV	V V	VI VI	VII VII
Set B 7 pairs	XIV XIV	XIII XIII	XII XII	VIII VIII	IX IX	X X	XI XI
Set C 7 pairs	XVII XVII	XX XX	XVI XVI	XV XV	XVIII XVIII	XIX XIX	XXI XXI

Chinese spring variety with full 21 pairs of chromosomes develops normally in contrast to 21 abnormal plants (right) each lacking 1 pair of chromosomes

When plant lacks group-1 chromosomes
When plant lacks group-2 chromosomes
When plant lacks set-A chromosomes
When plant lacks set-B chromosomes
When plant lacks set-C chromosomes
PAIR I MISSING
Plant reduced 1/5 in height, 3/4 in fertility 2/3 in tillers; has darker glumes
PAIR II MISSING
Cut ½ in height, tillering; coarse culms, leaves, extra spikelets; Flower parts between outer and inner husks; delayed maturity
PAIR XIV MISSING
Cut ½ in height 1/3 in culm thickness, over 3/4 in fertility
PAIR XIII MISSING
Short-stemmed, small-leafed plant sets seeds poorly at base of spike
PAIR XVII MISSING
Similar to XIV but has ½ normal number of tillers and very low fertility
PAIR XX MISSING
Shortened some in height and leaves but nearly normal in tillers

the first place, it's especially fortunate that so rare an occurrence as maturing of chromosome-deficient plants has happened occasionally in wheat and come to the attention of wheat breeders. And secondly, these aneuploids of wheat are abnormal enough for reasonable evaluation.

Functional similarities don't occur simply between the 2 chromosomes of each pair—actually, each pair has similarities with 2 other pairs. Thus the 21 chromosome pairs fall into 7 groups of 3. Within each group the 3 different kinds of chromosomes have much in common, although somewhat less in common than the 2 members of each pair have. Sears calls these homoeologous groups. Here's the functional grouping:

Chromosomes I, XIV, and XVII comprise the first group; II, XIII, and XX the second group; III, XII, and XVI the third group; IV, VIII, and XV the fourth group; V, IX, and XVIII the fifth group; VI, X, and XIX the sixth group; and VII, XI,

When plant lacks group-4 chromosomes

PAIR IV MISSING

Plant ½ normal height, thin-leafed and stemmed

When plant lacks group-5 chromosomes

PAIR V MISSING

Plant fine leafed and stemmed; matures later

When plant lacks group-6 chromosomes

PAIR VI MISSING

Plant dwarfed ½ normal height; fine stems and leaves, fewer tillers.

When plant lacks group-7 chromosomes

PAIR VII MISSING

A 3/4-size version of normal plants but a little less fertile at spike tip

PAIR VIII MISSING

Plant ½ normal height and thin-leafed; profusion of tillers

PAIR IX MISSING

Plant dwarfed a little but well tillered; matures late, and Spikes resemble the Spelt species

PAIR X MISSING

Similar to VI but with long awns and more tillers; tends to be one-sexed (male or female) and infertile

PAIR XI MISSING

Nearly normal vegetatively but frequent displacement of male with female flower parts cuts fertility

PAIR XV MISSING

Similar to IV but shorter-spiked

PAIR XVIII MISSING

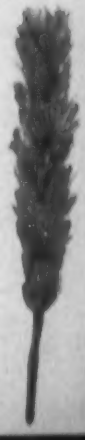
Fine-stemmed, fine-leafed plant, very late, develops slowly but a few survive (medium plant pictured on P.7)

PAIR XIX MISSING

Similar to VI but more vigorous, more fertile, and with longer stems and spikes

PAIR XXI MISSING

Plant similar to VII but a little shorter and with fewer tillers



and XXI make up the seventh group.

There's another way to look at these chromosome differences. Consider the 21 different kinds of chromosomes as 3 sets of 7 chromosomes. In a way, the sets have more in common than do the individuals in a set. This suggests that a basic set of 7 chromosomes is the common denominator of our wheats—a genetic unit rooted in the ancestral grasses of old. That would mean that a set of 7 is the building block and was used as such by nature in building the simple diploid grass with 2 sets of 7 into a hexaploid wheat with 6 sets of 7.

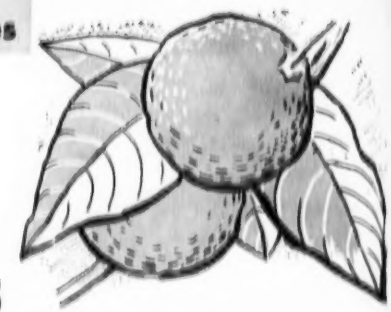
Since for each general type of chromosome there are 3 pairs of such chromosomes—that is, a total of 6—that are quite similar in the hexaploid wheat, the omission of one of these pairs doesn't leave the plant totally without the general function of that chromosome. The omission only reduces it to about two-thirds of its normal mechanism. That's why a nullisomic aneuploid doesn't clearly reveal all the gene effects that the missing chromosome has.

What's the practical value of these findings? Knowing which chromosome carries the gene for a particular character simplifies the geneticist's problem in recombining genes to make superior new plants. Having this knowledge, we're that much closer to our plant breeding goals.

For example, by crossing aneuploids with perfect plants of other varieties, Sears replaced the missing chromosomes with more desirable ones, particularly with chromosomes carrying genes for disease resistance. The substitution lines breed true for the introduced characters.

This merely suggests the advantage breeders gain from the aneuploid study. Knowing which chromosomes carry specific genes and being able to transfer those genes with considerable certainty broadens the opportunity to solve some genetic problems.☆

fruits and vegetables



MICRONUTRIENTS CAN BE OVERDONE

■ THE PROVERBIAL FEAST AND FAMINE has come to pass—but in reverse order—in the supply of three mineral nutrients in the soils of many Florida citrus groves. USDA research shows that a manmade overabundance is harming trees and reducing the fruit yield of oranges.

To overcome soil deficiencies of the micronutrients copper, zinc, and manganese, citrus growers have been adding these metals to the soil as fertilizers for many years. The copper fungicides sprayed on the trees also accumulate in the soil. It takes very little of these elements—less than 20 parts of any one of them per million parts of soil—for normal citrus development. Growers have been supplying more than enough, however, and toxic effects of copper have been observed in many orchards for the last several years. How does this affect the orange crop?

Plant physiologist P. F. Smith has studied the problem at the ARS Subtropical Fruit Field Station, Orlando, Fla. In 1951, he planted young Valencia orange trees in bottomless 55-gallon drums sunk in the ground and filled with white sand. To a complete nutrient solution, he added various combinations of the sulfates of copper, zinc, and manganese in order to compare the relative toxicity of the three minerals.

By 1955, when the test ended, these orange trees had rooted well into the normal soil below the drums. Examination showed that root formation had been retarded greatly within the drums when any of the three metals was at a high concentration. In the soil below, however, root development was normal. The normal roots at the lower depth partly counteracted the toxic effects of these metals on the tree as a whole.

Copper was the most toxic of the three metals—it took 15 times as much zinc and 50 times as much manganese as copper for about equal toxicity. A combination of two elements in excess was more depressive to root development in the drum than just a single metal. Where all three were high, root growth was cut more than 90 percent.

Excesses of metals in nutrient cultures were reflected in the greater metal content of the leaves—6 times as much manganese, 3 times as much zinc, and about twice as much copper as in normal citrus leaves.

Limited evidence from these experiments indicated that excesses of copper, zinc, or manganese affected the fruits in yield only. The crop of fruit borne during the last year of the experiment showed that the oranges receiving high-copper treatment produced less. But aside from this, the oranges appeared normal in composition—for example, in total soluble solids, citric acid, and vitamin-C content—and in fruit color.☆

cool carrots keep

HYDROCOOLING, MULTIWALL BAG AIDED IN SUCCESS OF CARROTS IN POLYETHYLENE

IT TOOK a 1949 freeze that spoiled the appearance of carrot tops to introduce topless carrots to the buying public in the luxurious, eye-appealing polyethylene bag, or "cello" pack, as the trade calls it.

It took 6 years of research and industry trial to make carrots in polyethylene the success they are.

Hydrocooling—chilling the roots in ice water before packing—has been a most important factor.

USDA and industry researchers collaborated in studying the matter. They found that precooling was necessary in advance of prepackaging to cope with problems that arose because of the tightness of the package. Carrots packed warm in polyethylene bags cool slowly in the refrigerator car. In early trials, warm carrots often deteriorated, especially in the middle layers of the car. Shippers first tried ice in the wash water. That helped the situation quite a bit.

Agricultural Marketing Service scientists H. B. Johnson, W. R. Barger, and W. A. Radspinner and their industry cooperators showed, however, that separate cooling in a well-iced tank of water after washing is more satisfactory. Warm carrots at 72° F. can be cooled about 20° by immersion for 5 minutes in 38° water. That takes about 6 tons of ice per carload of carrots, but it greatly reduces the ice requirement in transit. It would take 3 days or more to cool a carload of carrots that much by conventional transit icing.

Some shippers do not find it practical to have separate hydrocoolers so continue to add ice to the wash water. These shippers find that covering the carrots with crushed ice while they are standing in the field trailer at the packing house is very desirable. The ice is then dumped into the wash tank with the carrots and continues to cool them during the washing operation.

Effective precooling is the key to another economy shippers wanted in order to offset the cost of polyethylene bags. Adequately chilled cello-pack carrots can be packed in a multiwall paper master bag that costs 15 cents less than the wire-bound wooden crate previously used. This, along with the reduced icing in transit, saves about $150 a carload. The studies showed that precooled cello-packs can also be packed in corrugated cardboard cartons, for which some shippers and receivers have a preference.

Commercial-scale trials with the new method of cooling carrots and shipping in less-expensive cartons demonstrate its practical value.☆

HYDROCOOLER CHILLS carrots about 20° F. so they keep well in "cello" and multiwall paper bags during shipment with minimum transit icing

ONE-POUND "CELLO" pack is weighed. Precooling made the bag practical. It's convenient to retailers, attractive to customers.

MULTIWALL PAPER bag of 48 1-pound packages is sewed. Cheaper master pack and reduced icing save $150 per carload.

IT PAYS TO GRAZE MODERATELY

GREAT PLAINS grazing land, despite the rugged topography, can support thousands of beef cattle. But land must be grazed and maintained properly.

Long-term trials prove happy medium of use saves the range and makes cattlemen more money

RANGE management research is attempting to perpetuate the use of millions of acres of Great Plains grazing lands and to increase their productivity. These lands, which once supported uncounted thousands of buffalo, are better suited to livestock than cultivated crops. Getting the highest yield of beef without damaging the range is a major problem.

For drier portions of the Northern Great Plains, solution is being sought by cooperative efforts of USDA and Montana experiment station scientists. Their research is conducted at the U. S. Range Livestock Experiment Station, located at Miles City.

The work involves range grazing under three intensities of use—heavy, moderate, and light. Included are studies of soil moisture, moisture infiltration, and soil compaction; plant density, composition, and production; and rates of livestock reproduction and gains on the different rates of grazing. Four important browse species of the area—greasewood, winterfat, shadscale, and big sagebrush—have been studied to determine utilization and the effects of winter grazing on these plants. Chemical analyses have been made at monthly intervals (November through March) to determine the content of protein, phosphorus, and carotene.

These studies have shown that there is a happy medium of use under which cattle and range thrive and gross return reaches its peak. They have also shown that there are degrees of use that can spell disaster to cattlemen in the long run. Because of widely varying weather conditions from year to year, however, the injurious results of a heavy rate of utilization may develop slowly.

Certain phases of the experiments began more than 20 years ago. But only in the past 7 years has it been possible to use breeding cows that are the progeny of the stock raised under each of the three grazing intensity patterns. Results thus obtained provide information on cumulative effects of the grazing intensities—not available, of course, in the earlier years of this research.

Results in 1955 indicate that maximum gross return per acre occurs under moderate grazing—that calves so grazed average "top good" grade at weaning, compared with "low good" for heavy grazing and "top good" to "low choice" on light grazing.

Six lots of cows are being used in the experiment—two lots for each grazing intensity. Intensities cover a range of 1 cow to each 23 acres for heavy grazing, 1 to 31 acres for moderate, and 1 to 39 acres for light. Under *heavy* grazing, 71 percent of the cows produced calves. These made an average daily gain of 1.6 pounds. Pounds of calf produced per cow at weaning averaged 268, and pounds of calf per acre amounted to 11.6. On *moderate* grazing, 86 percent of the cows produced calves. These gained 1.8 pounds daily and averaged 428 pounds at weaning, calf pounds produced per acre amounting to 12.1. Ninety-three percent of the cows produced calves in the *light* grazing experiment. These gained 1.9 pounds a day, weighed an average of 438 pounds at weaning, and provided 10.5 pounds of calf per acre.

These results favor moderate grazing over heavy or light. Heavy grazing not only resulted in smaller calf crops and lighter gains but also caused some injury to the range over a long period. Light grazing proved that there is an optimum rate of use that provides desired response in beef and range yield—that below this

point, ranchers are not getting the most out of their range.

Grazing under heavy intensity, the studies revealed, reduces range plants' vigor. It also causes a shift from tall to short grasses, including blue grama and buffalo grass—not as productive as the native tall grasses. Further, tall grasses stick up through the snow, permitting the stock to see and eat them readily during the winter.

The studies also show that heavy grazing causes changes in soil composition. Trampling leaves little grass residue to rot and replenish the soil. This affects both soil structure and fertility. Frequently, trampling as a result of overgrazing hardens the soil surface so that moisture permeation is retarded to some extent.

The Northern Great Plains area embraces parts of Montana, North and South Dakota, and a corner of Wyoming—114 million acres, 85 million of them suitable for grazing. Aim of these range grazing experiments is to determine average response under virtually all the weather and moisture conditions that livestock and range encounter in that area over a period of years. Short-term experiments have not proved trustworthy.

It has taken fully 20 years of research at Miles City to observe changes in vegetative, soil, and moisture conditions accruing from heavy grazing. Such use, if carried to extremes, could permanently impair the productivity of these lands.☆

WHEN SNOW blankets range, ranchers must provide cattle with supplemental feed—usually hay cut from range during the summer.

poultry

The growth factor in feathers

■ USDA POULTRY NUTRITIONISTS are seeking the identity of an unknown growth factor that has been discovered in feather meal through the experimental use of this product as a poultry-feed ingredient.

Repeating trials definitely show the potency of this mysterious substance. Chicks fed rations containing 4 percent feather meal averaged 376 grams (about three-fourths of a pound) in 4 weeks as compared with 348 grams for controls fed the same rations without feather meal.

Laboratory tests to identify the growth factor are being conducted by ARS poultry nutritionist Henry Menge at the Agricultural Research Center, Beltsville, Md. Results thus far indicate that the substance is *inorganic*. This has been shown through ashing of the feather meal at 700° C. (over 1000° F.) for at least 5 hours—enough sustained heat to completely consume organic materials. The ashes remaining gave the same growth response as had feather meal used in the "raw."

Analysis of the ash by spectrograph shows the substance contains at least 15 different minerals in widely varying quantities. Silicon is most plentiful, with iron, calcium, and aluminum following in order. The spectrographs also revealed traces of copper, cobalt, lead, tin, manganese, vanadium, zinc, molybdenum, potassium, and even arsenic.

With these findings, however, the task of identifying the growth factor itself appears to have just begun. Growth factors have long been considered complex *organic* compounds, and many are. But ashing the feather meal proved this isn't always the case. And scientists at the Cornell and Texas experiment stations got response from *ashed* distillers' dried solubles, fish solubles, dried whey, and other materials that contain unknown growth factors. Since these are apparently inorganic too, Menge shares with his fellow researchers the belief that the factors all are trying to identify may be one and the same.

Meanwhile, the factor itself remains a mystery. Menge has tried feeding the minerals in the kind and quantity indicated by spectrographic and chemical analyses. He obtained no definite response. The Cornell and Texas researchers got negative or inconclusive results in similar feeding tests, including the feeding of the minerals one by one.

As a result of the feeding trials, however, Menge is willing to assume, conditionally, that the growth-promoting ability of the substance he is testing may lie in a happy combination of the minerals it contains. Such a combination might act to stimulate chickens' intestinal flora (such as bacteria) into action for better assimilation of feed.

He also points out that spectrographic analysis is no better than a fairly accurate way to determine the makeup of the substance. Thus, there's a possibility that the spectrograph is failing to reveal some element or elements vital to the substance as a growth promoter.☆

dairy

DAIRY FEEDS OF THE FUTURE

Researchers see more high-energy feed from grass-legume crops, more urea, molasses, fats

EXPERIMENTAL feeding of dairy cows for high-level milk production and body maintenance is beginning to indicate what well-fed animals will eat in the years to come.

USDA dairy scientists are certain that high-energy feeds will top future menus that a dairyman selects for his herd. There will be adequate protein—but not an oversupply. Cows may also have greater access to such additives as urea, molasses, and tallow, as well as vitamins for relieving certain metabolic disorders.

High-energy feeds will come from the same sources as they do now. But ARS dairy nutritionist L. A. Moore foresees an increased proportion of such feed coming from grass-legume pasture crops rather than from grain supplements as at present.

Grassland farming is becoming increasingly important. Research has already shown the high energy derived from grass-legume crops cut and stored as hay or silage at the optimum stage to provide the most in feed value. Test after test demonstrates that such crops provide the best feed when harvested well before maturity. In this condition, they supply a substantial part of the energy and protein-bearing feeds that cows need for high-level production. Grain is now the usual standby for this purpose.

The swing to grass-legume hay and silage doesn't mean that dairymen of the future will discontinue feeding grain concentrate. But it does mean they aren't likely to seek high-level-protein feed in grain alone if other sources are available.

Grass-legume pasture crops will be one source. Another source may be urea as a feed additive. Cows, because they are ruminants, convert urea to amino acids and protein. Urea, made synthetically, is most effective when added to home-grown-grain rations. Such rations rarely contain more than 10 percent protein—which permits the utilization of added urea by 60 to 80 percent. In grain feeds (commercial) that have 14 to 18 percent protein, addition of urea is wasteful since utilization then seldom tops 40 percent.

Use of urea in dairy-cow diets of the future will depend then—as it does now—on the cost of this product in comparison with the cost of grain feeds. It will pay, for example, if the cost of a pound of urea, plus 6 pounds of carbohydrate concentrates, is less than the cost of 7 pounds of protein concentrates from various sources.

Molasses has a definite place in feed rations for beef cattle, and its use in dairy rations can be expected to increase in the future. A byproduct of cane, beet, corn, and citrus sugar manufacture, "blackstrap" molasses serves the two-fold purpose of adding nutrition and palatability to feeds. It is frequently mixed with ground feeds and is even used as a pasture spray to increase the palatability, nutrition, and intake of low-quality pasture crops. Although its availability for feed use once depended largely on the demands of the alcohol industry, increasing synthetic manufacture of alcohol has left larger quantities of molasses for feed. Since 1943, the use of blackstrap molasses in feed has mounted steadily.

Replacement of soap by synthetic detergents has made available large quantities of inedible tallow. This product is being used successfully in cattle, sheep, and poultry rations. Its value as an ingredient of calf starter rations has been demonstrated by cooperative research by the Connecticut experiment station (Storrs) and ARS. A ration containing 10 percent stabilized tallow, fed at the rate of 4 pounds a day per calf, resulted in an increase of 5 to 6 percent in the calves' rate of gain. Tallow cost will determine its future use as a feed ingredient.

Nutritionists see little chance of material change in the various minerals used in feeds. It is assumed that commercial feed manufacturers add the more common elements such as calcium and phosphorus, as well as sodium, chlorine, and iodine in the form of salt. These feeds likely contain trace minerals such as iron, copper, manganese, and cobalt. All these, it may be expected, will be a part of mixed feeds of the future.

Work at the Ohio experiment station over a period of about 10 years has already shown that milk fever can be prevented in cows by feeding 5 to 30 million units of vitamin D daily for 3 to 7 days before the birth of a calf and 1 day after birth. Milk-fever-prevention rations, for use at such times, are offered by some feed companies. Greater use of vitamin D for this purpose in the future seems almost certain to develop.☆

food and home

How we use Food

SURVEY AIDS NUTRITIONISTS, TEACHERS, PRODUCERS, MARKETERS

HOW do homemakers prepare and serve the foods that come into their kitchens? Nutritionists must have the answers before they can estimate dietary adequacy. Some methods of preparation and cooking may reduce the vitamin and mineral content of the food served, and heating may change some nutrients into forms less easily used by the body.

Food and nutrition teachers want the answers so they can direct their teaching toward foods that supply shortages and toward methods that best preserve nutritive content. New recipes and ways of serving that fit into a community's existing patterns are more likely to be adopted.

Marketing interests use the answers in promotion campaigns. The information is especially helpful to food producers and distributors.

To get some answers on use of foods, USDA food economists arranged for interviews with 850 homemakers in three cities—Birmingham, Ala., Indianapolis, Ind., and Everett, Wash. The women were asked how they served and how much they used of a number of foods—eggs, several forms of milk, table fats, sugar, potatoes, cabbage, carrots, and canned tomatoes. Information was also obtained on home baking. The women's answers were tabulated and considered in relation to number in the family, family income, and whether the homemaker was employed outside.

This is the first ARS survey specifically on household use of food. Here are some of the findings:

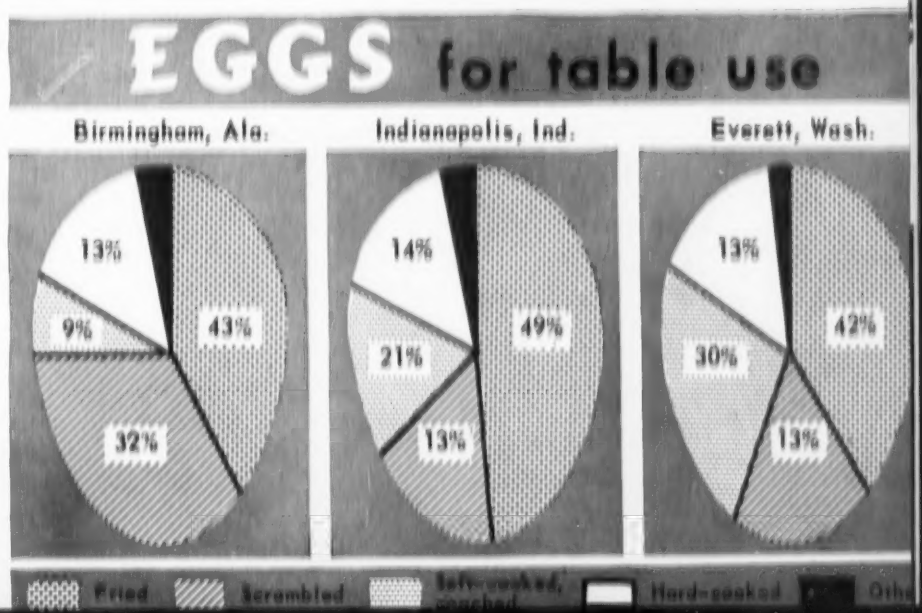
Of the eggs used—consumption averaged 7 per person per week—most were served as such rather than as part of a sauce, cake, or other mixtures. Although three-fourths of the eggs used as such were served at breakfast, more than half the households served eggs at some other meal of the day at least once a week.

All households in the study used some milk—as fresh fluid, evaporated, or nonfat dry—during the survey week. The food economists found, however, that persons in all age groups drank less than recommended amounts of milk. Several age groups drank so little milk as a beverage at home that, even if they consumed other dairy products or milk away from home, they probably could not get enough to meet their nutritional needs. Adolescents probably fared the poorest in this respect.

Nearly all of the Birmingham homemakers baked quick hot breads—chiefly biscuits and cornbread—at least once a week. Everett women prepared a greater variety of baked goods than those in the other cities. A considerable number made griddle cakes, cake, pie, and cookies. Indianapolis homemakers did the least baking, according to the survey.

Many more women in each city served potatoes mashed than in any other way. Cabbage was served raw more often than cooked in all three cities. Birmingham and Indianapolis also preferred carrots raw, but Everett homemakers served cooked carrots twice as often as raw. Canned tomatoes were served most often in mixtures with other foods, which probably results in a high loss of ascorbic acid since mixtures are often cooked for a long time. Such findings are used in estimating the nutritive value of family food supplies.

These and other aspects of the survey are reported by ARS researchers C. LeBovit and F. Clark in USDA Agriculture Information Bulletin 146, "Household Practices in the Use of Foods, Three Cities, 1953." This will be available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.☆



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HARD SEED and slow germination of Pima S–1 extra-long-staple cotton have been counteracted experimentally by immersing the seeds for 1 to 2 minutes in a hot-water bath at 185° F.

This practical treatment developed by USDA agronomist V. T. Walhood will serve until the hard-seed character is bred out of S–1. Several breeders are trying this—a slow process at best.

Sometimes up to a fourth of the seeds are hard and moisture resistant—may take months to sprout. Walhood's treatment doubled germination at 3 days.

In the Southwest, where irrigated seedbeds dry rapidly, Pima S–1's germination is slow and irregular. Farmers must overseed so they can get a good stand if they grow this superior variety.

SCIENTISTS AT USDA'S Agricultural Research Center, Beltsville, Md., have learned how to use light in a greenhouse to make Weigelas pass up their usual rest period during autumn's short days.

ARS plant physiologists R. J. Downs and H. A. Borthwick artificially lengthened the light period for Weigela from 12 hours—the normal daylength around mid-October—to 16 hours a day for a 2-month period under greenhouse conditions. This boosted growth from the 2½ inches of short-day plants to 19 inches. Ordinary light bulbs were effective.

The scientists also learned that the uppermost pair of leaves apparently controls growth of a Weigela branch—keeps it from growing during short days. In a greenhouse test, where growth had stopped due to the shortness of the daily light period (12 hours), removal of the terminal pair of leaves caused the branches to grow actively again. Removal of lower leaves failed to cause growth. This artificially induced growth stopped unless the plants had a daylength longer than 12 hours.

In the experiment, plants on a 12-hour day had large, conspicuous, hard buds at the ends of the branches and in the leaf axils. The 16-hour plants were still growing and therefore had no terminal buds. Their axillary buds were soft and inconspicuous. Increasing the hours of light or removing the terminal pair of leaves caused many of the buds to swell within a week and to resume their growth within about 12 days.

Previously, USDA research showed it's possible to force sugar beets, cereals, chrysanthemums, and many other crops to bloom when desired and to prevent sugarcane blooming. Each such gain in our understanding of plants and light advances us toward our goal of efficiency.

YELLOW-ENDOSPERM types of grain sorghum collected in Africa are being crossed with domestic varieties in hope of improving crop nutritive quality.

USDA agronomist O. J. Webster, working in cooperation with several Great Plains State experiment stations, has made some yellow-endosperm crosses that have about one-eighth the carotene (vitamin A precursor) needed, for example, in a broiler feed. They hope to intensify the carotene some by intercrossing the various yellow types.

By the use of certain African types, there's hope of breeding out our present sorghums' tendency to mold during rainy autumns. Sorghum, now largely a crop for the Great Plains, could then become a satisfactory grain crop for the rain belt.

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